Radiation Effects and Reliability Considerations for the Application of Photonics in Space Systems

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ABSTRACT

As civilian and military spacecraft continue to evolve, meeting performance demands will become particularly challenging because performance levels will be constrained by severe cost and weight restrictions. To meet these challenges, new technologies will be employed that can provide desired performance levels within the framework dictated by these constraints. For example, in an advanced spacecraft, cost and weight savings could be realized by designing a completely autonomous (no uplink) spacecraft that uses optical communication as a downlink. While the absence of an antenna and radio offers considerable weight savings, there will be increased demands for greater on-board data transfer and processing rates. In addition to the optical downlink, photonics can provide the necessary on-board performance at high data rates.

Very recently, photonic components and fiber optic links have been flown as experiments on various spacecraft. In addition, their use in a wide variety of other fields such as ground-based communication systems, automotive applications and medical applications, has established the proven capabilities of photonics. However, the evolution of photonic system specifications for space applications has just begun. For many of these systems, reliability and radiation hardness assurance have not been established for photonic components. While there is limited commonality between assurance concerns for photonics and traditional electronic subsystems, there are several areas where the two technologies differ significantly. These include optical system integrity, aging degradation mechanisms, manufacturing process variations, shock and vibration resistance, and radiation-induced performance degradation. In addition, failure and degradation of a photonic system can have a different impact on overall spacecraft integrity relative to the effects of electronic system failure.

In this paper we discuss the assurance issues associated with the insertion of photonics into space systems, both military and civilian (NASA and commercial). It is interesting to note that the radiation effects problems for photonics can be very different for military vs. non-military space applications. Recent work in this area at JPL will be emphasized.

1998 IEEE Aerospace Conference

Snowmass

at Aspen, Colorado

March 21-28

FINAL CALL FOR PAPERS

1998 IEEE AEROSPACE CONFERENCE

ANNOUNCING THE 4TH IEEE...
JUNIOR ENGINEERING & SCIENCE CONFERENCE

. . .to be held in conjunction with our 1998 Conference in Snowmass, Colorado
Mar 21- Mar 28, 1998

WHO IS ELIGIBLE TO PARTICIPATE:
Any child, - kindergarten through high school, attending the conference as an official guest of a registrant may present a paper as a Junior Engineering & Science Speaker.

TOPICS
Topics with direct or tangential relationship to science, engineering, or mathematics are encouraged.

PAPERS SHOULD FALL INTO ONE OR MORE OF THE FOLLOWING 3 CATEGORIES :
1. An original idea accompanied by supportive reasoning and data,
2. An experiment, invention or "field work",
3. A review summarizing a topic of interest to the Junior Speaker.

PROCEDURE:
1. Call or write the junior conference chair, Barry Madore, to let him know of your child's interest. Please include both your work and home phone numbers as well as your address.

2. Speakers at the Junior Conference are requested to prepare 8 1/2 x 11 inch viewgraphs (transparencies, for projection with an overhead projector) to use in their presentation. Help from an adult is definitely allowed and encouraged. A viewgraph projector, a pointer and a ***screen will*** be available for their use at the conference. There will be opportunity for them to practice with the overhead projector prior to their presentation if they wish.

3. The presentations can be of any length from 2 to 20 viewgraphs and from a few minutes to 20 minutes.

4. Mail two clean paper copies of the viewgraphs to the Chair of the junior conference by **January 9, 1998. The** committee will duplicate them and prepare a Proceedings to be distributed at the conference to all the participating children.

5. The first Viewgraph should consist of a short biography, including the child's age, education background, year in school, hobbies, intellectual and sporting interests, gender, and any other pertinent information (and maybe a photo).

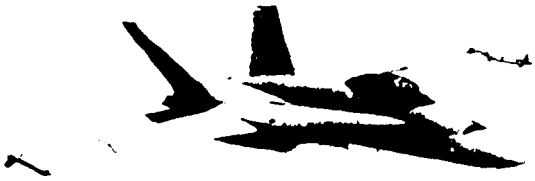
6. Include a registration fee of $25, payable to the IEEE Aerospace Conference. Mail checks to Barry Madore at the address below.

The Junior Engineering & Science Conference is being planned for **Tues, March 24 in** the **Top Of The** Village meeting room just above their Jacuzzi & swimming pool. The date and/or place could change if **a** program conflict develops — we will inform YOU later. If YOU have any questions or suggestions, please contact:

Junior Engineering & Science Conference Chair:

Barry Madore
Caltech, IPAC 100-22
Pasadena, CA 91125

Work:Work Fax: E-mail:
818-397-9512 818-397-9600 barry@ipac.caltech.edu



THE CONFERENCE

The internationally attended IEEE Aerospace Conference is organized to promote interdisciplinary understanding of aerospace systems, their underlying science and technology, and their applications to government and commercial endeavors. The annual week long meeting is sponsored by the IEEE Aerospace and Electronics Systems Society (AESS).

WHAT SETS THIS CONFERENCE APART

The high quality of papers and presentations. Typically 15°/0--3570 of presentations are by IEEE Distinguished Lecturers, probably the highest of any conference. Daily plenary sessions feature renowned scientists /engineers and for high ranking members of the government or military.

Exceptional access to authors and invited speakers. Almost all speakers attend the entire week and are available throughout the sessions, breaks, lunches, nightly Conference dinners, shared living arrangements and the social and recreational activities that complement the technical program. These provide extraordinary opportunities for follow-on discussions and collaborative dialogue with aerospace pacesetters.

These ongoing exchanges frequently extend years beyond the week-long conference, benefiting the participants, their organizational sponsors, the industry, and the engineering and scientific professions.

Multidisciplinary focus. This is the one general conference that facilitates cross fertilization of aerospace disciplines and dialogue among members of government, industry and the academic community.

Professional Development of Authors. Through its unusually thorough and supportive review process, the conference provides expert guidance from senior engineers and scientists as well as language reviewers and the opportunity for instructive interaction between author and reviewers. First-time authors are nurtured.

Journal-Quality Proceedings. Papers receive the more thorough technical review and provide the significantly greater technical depth characteristic of journal articles rather than conference papers. The 4-volume '97 Proceedings totaled 2,244 pages, with papers averaging over 15 pages each. Proceedings are distributed during Conference registration.

Science and Aerospace Frontiers. This very popular daily plenary session features internationally prominent researchers working on the frontiers of science and engineering topics which could have significant prtents on aerospace and the world we live in. Registrants are briefed on cutting edge technologies emerging and intersecting with their disciplines.

A VIATION WEEK & SPACE TECHNOLOGY ON THE **IEEE** AEROSPACE CONFERENCE:

February '96 Conference: ".. .the well-structured event is becoming one of the nation's most prominent and influential aerospace professional ***venues,"*** (Feb. 26, 1996 issue, pg. ***60)***

February '97 Conference: "Now in its 18th year, the IEEE event has established itself as one of the premier policy and technical forums for civil, commercial and military aerospace issues. The 1997 conference attracted approximately 300 International attendees and 137 technical and plenary presentations - triple the number of 1995 papers." (March 10, 1997 issue, pg. 57)

TECHNICAL PROGRAM

This Call invites papers reporting original ***work*** or state-of-the art reviews that will enhance knowledge of:

1) Aerospace systems, science and technology
2) Applications of aerospace systems or technology tc military, civil or commercial endeavors
3) System engineering and management science in the aerospace industry
4) Government policy that directs or drives aerospace programs, systems, and technologies.

All conference sessions will be held **in Snowmass Village at the Conference Center and the Wildwood Hotel.**

ABSTRACT & PAPER

A 500 word abstract (4 **copies) containing your name, address, phone number, and E-Mail address** must be received by the Program Chair, Ed Bryan, by **August 15, 1997.** Please mail the four copies to:

Ed Bryan, Program Chair
IEEE Aerospace Conferences Office
2408 Palm Avenue,
Manhattan Beach, CA 90266.

Please, do not e-mail or fax your abstract.

Accept/reject notices and author instructions will be sent within two weeks, Three copies of a complete paper, 8 - 20 pages or longer if justified, must be received by the Program Chair by **Friday, October 10,1997.**

FOR MORE INFORMATION

VISIT OUR WEB SITE: **www.aeroconf.org**
for updates, instructions, and the latest information

TECHNICAL QUESTIONS:

PROGRAM CHAIR
Ed Bryan
581 Paseo Mirarnar
Pacific Palisades , CA 90272

e-mail: edbryan @alumni.caltech.edu
Phone: 310-454-9461
Fax: 310-454-6617

GENERAL ISSUES:

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Mike Johnson
Beth Leitereg
2225 Roscomare Road,
Los Angeles, CA 90077-2222.

e-mail: johnson @ee.ucla.edu
Phone: 310-472-8019

SOCIAL COMMITTEE PLANS AND DINING

The Social Committee is arranging a Saturday evening get-acquainted pizza dinner party and reception, full catered dinners in the main conference room during breaks in four of the evening meetings, two hot catered picnic mountain lunches, and a poster dinner party. The costs for these activities and meals are included in the registration and guest activities fees.

Also, a banquet (at additional charge) and an expanded activity program for guests are in the planning stages.

TRAVEL AND LODGING

Travel has been negotiated between Los Angeles and Snowmass round trip for $450, including ground transportation. Flights from other major cities are in negotiation — details will be available later.

Lodging at special rates has been obtained for a limited number of rooms in hotels, inns, and 2, 3, and 4-bedroom condominiums in Snowmass Village near the Conference Center. ***Priority will be given to authors and their guests whose papers are completed and accepted the earliest, and whose registration and lodging payments are sent in the earliest.***

REGISTRATION

REGISTRATION FEES Incl Activities & Meals Pkg	Received By Nov 14, '97	Received After Nov 14, '97	Received After Mar 13, '98
IEEE Members	$485	$585	$685
Non Members	$535	$635	$735
Guests (Activities & Meals)	$125	$150	$175

Lodging rates per person for 7 nights lodging , 2 persons/bedroom

• **Hotel Wildwood (Official Conference Hotel)**	**$898**
• Stonebridge Inn	**$800**
• 2 BR/2 Bath Top of the Village	**$888**
• 3 BR/3 Bath Top of the Village	**$869**
• 4 BR/3 Bath Top of the Village	**$690**
• 2 BR/2 Bath Woodbridge Condos	**$640**
• Laurelwood Studios	**$874**

Registration, Travel, & Lodging Forms will be mailed in October '97

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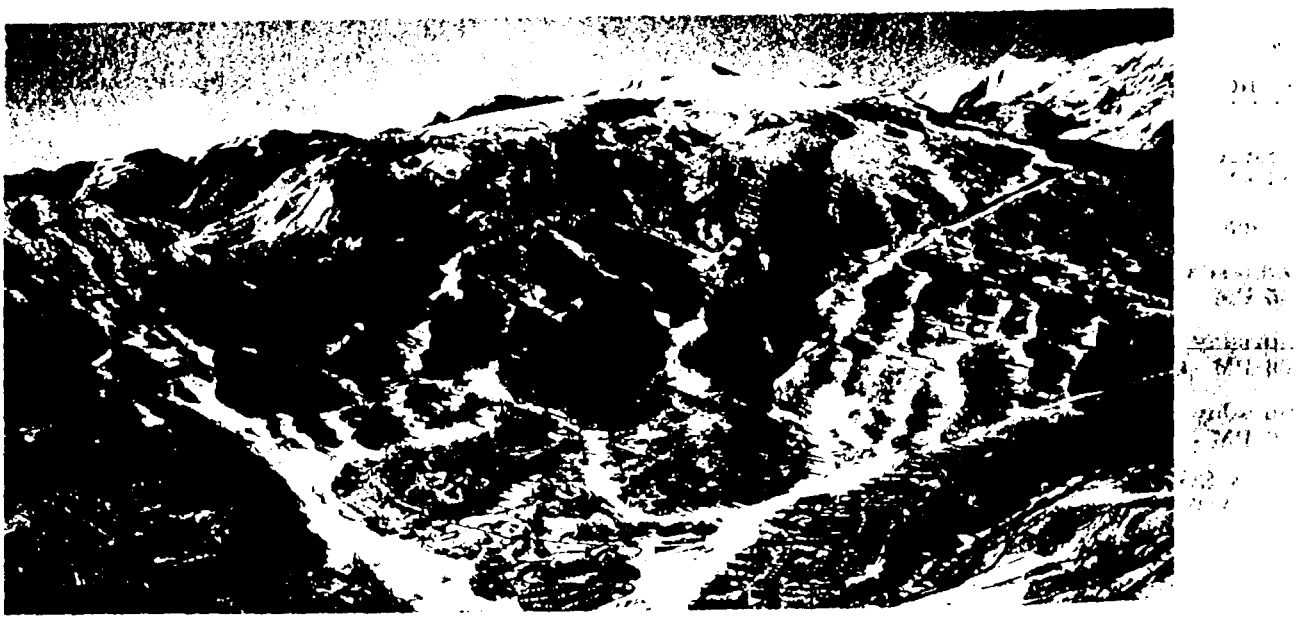
Social and Recreational Program

All of the lodging listed in the *Call for Papers* is close to the slopes, and some of them are actual ski-in ski-out facilities [n the registration package (and soon on our web site at www.aeroconf.erg) you will receive, there will be a map showing the locations of the hotels, inns, lodges and condos in our list, and their proximity to the slopes. Many accommodations have spectacular views, a swimming pool, hot tub, sauna, fitness room, and daily maid service. There are hotel-type accommodations as well as deluxe 2, 3, and 4 bedroom condos with complete kitchens, balconies, fireplaces, washers, and dryers.

Free shuttle service is available within Snowmass Village.

Activities in Snowmass and Aspen include downhill skiing, cros country skiing, ice skating, snowshoeing, snowmobileing, snowc touring, sleigh riding, twilight dinner touring, mounta ballooning, and tennis,. Snowmass has excellent restaurants ar is short shuttle ride from Aspen, with its outstanding restaurants, art galleries, museums, and historic minir attractions.



Registrants Receive With Their Registration Fee:

- Admission to all sessions,
- Social package: Eight meals, receptions & parties,
- Proceedings: Last year's 4 volumes contained 2,244 pages, This year's will be even more valued.
- Reduced rate Recreation Package for skiers (see below) and for non-skiers (in the planning stages).

Guests of Registrants Receive With Their Guest Fee:

- Admission to a few sessions of their choice,
- The same social package as registrants,
- An additional social program for guests only (in planning stage).
- Reduced rate Recreation Package for skiers (see below) and for non-skiers (in the planning stages).

Recreation Package for Skiers:

- For those interested in skiing, the committee is arranging for the purchase of 5-day all-mountain lift tickets for $225 (instead of the expected window price of $260) by registrants and guests. They are valid at Snowmass, Highlands, Aspen, and Buttermilk Mountains. Also, — NASTAR races for all who are interested — beginners to experts.

NOTE: All activities at IEEE Aerospace Conferences, including meals and social/recreation times, are intended to promote, enhance, and facilitate technical discussions and long-term professional and personal relationships.

SOCIAL COMMITTEE PLANS

The Social Committee is arranging a Saturday evening get-acquainted pizza dinner party, catered full dinners in the conference rooms during breaks in *four or five of the* evening sessions, and an 8-restaurant catered poster party Friday night.

For skiers, there are plans for both downhill and cross country group skiing, and mid-mountain catered hot ski picnics Monday and Thursday (which may also be available to non-skiers).

For non-skiers, the social committee will be assisting with alternative activities such as snowmobileing, snowcat touring, sleigh riding, mountain ballooning, twilight dinner touring, Aspen sightseeing, or ice skating.

Children are welcome guests at these social and dining events, and are encouraged to participate in the Junior Engineering & Science Conference on Tuesday,

Skiers, both registrants and guests, may purchase a recreation package which includes a 4-mountain, 5 day ski lift ticket for a cost of $225 compared to the estimated $260 price to the public. (This year our group discount is much less because it is high season.)

SOCIAL PACKAGE — MEALS, RECEPTIONS & PARTIES

FOR REGISTRANTS AND THEIR GUESTS — ALL COSTS ARE INCLUDED IN THE REGISTRATION AND GUEST FEES

Saturday Night March 21 — **Location - To Be Selected**

6:30 PM - Registration and Icebreaker pizza dinner party at a location to be selected. Replete with revelry, repartee, and other risibilities, end LOADS of great food! Pizza plus Chinese? Mexican? - TED

Sunday Evening March 22 — **Conference Center** — **Anderson Room**

6:45 PM - Conference Dinner

Monday Afternoon March 23 — **On The Slopes** — **Spider Sabich Picnic Palace**

1:00 PM - Catered Mid-Mountain Picnic A great piping hot lunch cooked for US right m the slopes.

Monday Evening March 23 — **Conference Center** — **Anderson Room**

6:45 PM - Conference Dinner

Tuesday Evening March 24- Conference Committee is still deciding – This will be announced later.

Wednesday Evening March 25 — **Conference Center** — **Anderson Room**

6:45 PM - Conference Dinner

Thursday Afternoon March 26 — **On The Slopes** — **Spider Sabich Picnic Palace**

1:00 PM - Catered Mid-Mountain Picnic A great piping hot lunch cooked for you right m the slope. Preceded by NASTAR races for all.

Thursday Evening March 26 — **Conference Center** — **Anderson Room**

6:30 PM - Conference Dinner.

Friday Evening March 27 — **The Timbermill**

6:00 PM -Concluding Celebration - The Second Traditional Annual Poster Party and Feast! An 8-Restaurant Catered Feast! Throughout the week we've shared brilliant engineering insights in the technical program end innovative Alpine techniques in the recreation program. On this final sight, we read and discuss the postec papers with the authors, and continue in the techno-socio environment of the final feasting program where we can also converse with various au thors from the week-long program, and you have the opportunity to ask those questions that have been nagging you all week or expose your latest theory.

PRELIMINARY 1998 CONFERENCE SCHEDULE

	Sat Mar 21	Sun Mar 22	Mon Mar 23	Tues Mar 24	Wed Mar 25	Thur Mar 26	Fri Mar 27	Mon
A M	Travel		Catered Mid-Mtn Picnic 1 P.M.			Catered Mid-Mtn Picnic 1 P.M.		Travel
P M	Travel Registration & Icebreaker Pizza Dinner Party "7 PM-???	Sun Session 4:30-10 P.M. (Includes Dinner)	Mon Session 4:30-10 P.M. (Includes Dinner)	Panel 5:00-6:30 Banquet 6:30-8:00 Jr. Eng & Science Conference 8:00-9:30	Wed Session 4:30-10 P.M. (Includes Dinner)	Thur Session 4:30-10 P.M. (Includes Dinner)	Fri Session 5:30 -12:00 P.M. Poster Party & 8. Restaurant Feast	Travel

PRELIMINARY TRACKS, SESSIONS, & ORGANIZERS

1.0 Plenary Sessions/Science & Aerospace Frontiers

TRACK ORGANIZER 310-545-9670		ROBERT PROFFT	President & CEO Trans-Spectrum Corporation IEEE Aerospace Conferences Program Chair1994, Conference Chair1995, 1 996, Board of Directors Chair, 1994 -Present

2.0 Global Virtual Presence

TRACK ORGANIZER 505-846-6243		CHRISTINE ANDERSON anderson@plk af.mil	Director, Space Technology. USAF Phillips Laboratory, AIAA Fellow, Member, AIAA Board of Directors
TRACK COORDINATOR 505-846-5785		GENE BEDNARZ bednarz@plk af.mil	Senior Scientist, Space Technology Directorate. USAF Phillips Laboratory, Kirtland AFB, NM
2 1	Hyperspectral Remote Sensing for GVP 505.846-7982	JOHN O'HAIR ohair@plk af mil	Program Manager for Spectral Sensing Support, Lasers & Imaging Directorate, USAF Phillips Laboratory.
2 2	Space Laser Technology 505-846-4020	LINDA DEHAINAUT dehainal@plk af mil	Optical Engineer, Laser Systems Div., Laser & imaging Directorate. USAF Phillips Laboratory.
2 3	Lightweight Structures And Optical Systems 505-84?5-8250	ALOK DAS dasa@plk af mil	Technical Director, Space Vehicle Technology Division, Space Tech Directorate USAF Phillips Laboratory.
2 4	High Accuracy Pointing, Control, Tracking and Stabilization Technologies 505-846-6071	JESSE LEITNER leitnerj@plk af mil	Project Leader for Autonomous Guidance. Navigation & Control, Space Systems Tech Division, Space Technology Directorate, USAF Phillips Laboratory..
2 5	Knowlege On Demand And Data Fusion 505-846-0484	BABU SINGARAJU singaraju@plkaf mil	Chief. Space Mission Technologies Division, Space Technology Directorate, USAF Phillips Laboratory, Kirtland AFB, NM
2 6	Payload Support Technologies 505-846-2767	CAPTAIN TIM MURPHY murphyt@plk af mil	Deputy Chief, Space Vehicle Technologies Division, Space Technology Directorate, USAF Phillips Laboratory.
2 7	Protection Technologies 505-846-0961	MARK HOPKINS hopkins@ kafb aero org	Senior Project Eng, The Aerospace Corp. Advanced W'capons & Survivability Directorate, USAF Phillips Laboratory, Kirtland AFB, NM

3.0 21st Century Space Mission Management & Design

TRACK ORGANIZER 818-354.7023		KANE CASANI e kane casani@jpl nasa gov	Manager of NASA's New Millennium Program, JPL NMP is an advanced-technology validation flights program enabling NASA's 21st century science mission.
3.1	Autonomous Systems For 21s! Century Space Missions 818.354.2597	DOUG BERNARD Douglas. e. Bernard@jpl,nasa gov	Supervisor, Flight System Engineering Group, JPL Leads the team developing the "Remote Agent " Autonomy technology for the New Millennium program's Deep Space I Mission
3.2	Space Mission Technologies and Management In The 21st Century 818-354-7024	BOB METZGER robert.m metzger@jpl.nasa gov	Business operations manager, New Millennium Program, JPL Implementing new innovative business practices for the advanced technology validation program
3.3	21st Century Space Missions 818.354-7024	BOB METZGER robert.m metzger@jpl nasa gov	(same as above)
3A	Space Mission Design Processes In The 21St Century 818-3 M-6147	JOHN PETERSON john c.peterson@jpl nasa gov	Manager, Integrated Designs Systems, Jet Propulsion Lab. 7 patents, more than 30 publications & awarded NASA's Exceptional Achievement Medal

4.0 Flight Systems Technologies

41	Spacecraft Attitude Determination and Control 310-416-5219	A DORIAN CHALLONER adchalloner@ccgate hac.com	Scientist, Hughes Space & Communications with U.S Patents in the field of spacecraft control systems, dynamics & modeling
	310616-4858	ANDY WU yawu@ccgate hac com	Principal Scientist, Mechanism, Cryogenics & Controls laboratory, Hughes Aircraft Interests in precision pointing & tracking, micro-processor based digital adaptive control, large space structures
4.2	Space Power Systems 505-846.1454	DEAN MARVIN marvind@k afb aero org	Space Power Systems/Senior Project Engineer, Space Technology Directorate, The Aerospace Corp.
4 3	Smart Structures Dynamics & Control 408.6 S6-2936	JANET STUART jgstuart@aa nps navy.mil	National Research Council Research Associate, Naval Postgraduate School.
4A	Computer-Aided Engineering of Future Avionics Systems 937-255.4831, X3486	GREG CREECH creech@elwpafb af.mil	Computer-Aided Engineering Future Avionics Systems Research Engineer, RF Components & Technology Branch, Avionics Directorate, USAF Wright Laboratory.
4.5	Military Avionics 505-848 .587S	JOHN MBORKY jborky@bdm com	Received Digital Avionics Award for 1992 Vice President of Technology & Logistics, BDM Federal, Inc
	973.255-3627	PAUL MCMANAMON mcmanapf@aa wpafb af mil	Acting Chief Scientist Avionics, Air Force Research Scientist Interested in Sensor Technology for Aerospace Applications Chairman acting IRIS & chairman of the July 1996 London NATO/I RIS Conference
4.6	Manufacturing and Assembly of High Density Interconnect Boards 310-814-1898	BILL BJORNDAHL bill.bym]dahl@ww com	Senior Technologist, advanced manufacturing, Electronic Systems & Technology Division, TRW. Interest in advanced technology for manufacture of complex high density electronic assemblies
4.7	Electronic Packaging for Aerospace Applications 206-657-3171	JAMES LUCAS james p lucas@ boeing com	Electronic Packaging Engineer, Advanced Packaging & Analysis, Boeing Defense & Space Group

4.8	**Microwave & Integrated Circuits** 310-812-2262	CHRIS GROSSMAN chris grossman@trw.com	IEEE Microwave Prize, 1994; Winner of TRW Chairman's Award for Innovation, 1997. Main interest: III - V Integrated Circuits.
4.9	**MEMS** 818-364-7215	ASAD MADNI berl madni@aol.com	President & CEO, BEI Sensors & Systems Co. Internationally recognized authority in the field of intelligent system design & signal processing. More than 60 publications & numerous patents.

5.0 Air/Space Flight Systems

5.1	**Aircraft Flight Testing** 805.? 77-2555	T. GLENN COLEMAN tgcoleman@aol com	Captain, USA F.F-16 Flight Test Engineer, Avionics & Armaments Division
	301-757-4452	JENNIFER O'CONNOR oconnorjm%am4@mrnawcad navy. mil	Flight Loads Engineer, F/A- 18E/F Integrated Test Team, Naval Air Warfare Center, Aircraft Division, NAS Pat. xent River Interest in air vehicle engineering, load flight test, structural dynamics and strength analysis
5.2	**Aerospace Test & Evaluation**	ROBERT TAYLOR taylorr%eww@mhs elan af mil	Principal Engineer, Project Planner & Technical Staff, Electronic Warfare & Test Evaluation. Benefield Anechoic Facility, Edwards AFB Computer Science Corp Adv. Tech. Div.
5.3	**Satellite Systems for Wireless Communications** 303-442-5330	ROBERT E MUNSON FAX 303-442-3401	IEEE Distinguished Lecturer, Consultant on innovation Low Profile & Efficient Antennas; Holds 30 Patents on Microstrip Antennas, Including the First Patent
5.4	**Commercial Satellite Systems Design** 415-424-2702	BILL STRAKA bstraka@svl ems lmco.com	Senior Staff Scientist, Lockheed Palo Alto Research Lab, Lockheed Martin Missiles & Space. Interest in satillite systems, astro dynamics, sensor systems
5.5	**System Design Optimization** 818-306-6157	ALEX FUKUNAGA alex fukunaga@jpl.nasa gov	Senior Member, Information Systems & Computer Science Staff, JPL Interest in optimizatiom, artificial intelligence, evolutionary computation
5.6	**Autonomous Systems** 818.354-2744	GUY K MAN guy.k man@jpl.nasa gov	Chair, NASA New Millennium Integrated Product Development Teams. JPL
5.7	**Advanced Launch Vehicles I** 714.896-5855	WILLIAM A GAUBATZ gaubatz@apt mdc.com	Director, Business Dept. for Advance Space Systems, McDonnell Douglas Aerospace. Reponsible for identifying & understanding the needs of military, civil & commercial customers & developing advanced concept & programs m satisfy those needs
5.8	**Advanced Launch Vehicles 11** 805-572-5745	STEVE FRANKLIN sfrankli@ladc lockheed com	Avionics Systems Engineering, Allied Signal. Interests in inertial navigation systems, redundancy, management, fault protection
5.9	**GPS Applications & Technology** 310-336-8733	PHILIF' DAFESH dafesh@courier4,aero.org	Engineering Specialist, Communication Systems, Aerospace Corp , Physics Faculty Member at CSUDH. Member IEEE, APS, Sigma PI Sigma & Tau Beta Pi.
5.10	**Small Satellites & Enabling Technologies** 3[0-206-480[	J. MICHAEL JOHNSON johnson@ee ucla edu	Electrical Engineering Consultant, president of North Shores Associates, U.S. Patent Agent.

6.0 Antennas & Radar

61	*Antennas* 415-424.2633	WALTER S GREGORWICH	Senior Engineer. Advanced Systems at Lockheed Martin Research & Development Laboratory, USAF Colonel (Retired)
6.2	**Antennas For Wireless Comm** 303-541-6911	PATRICK PERINI pperini@uswest com	U.S West Advanced Technologies in the Wireless Technology & Eng Group. In[crests include antenna development for wirless comm *smart* antenna systems, & propagation analysis
63	**Space-Based Radar; Multi Sensor Remote Sensing** 505-84S-4412, X427	STEVE FIEDLER	Chief of Space-Based Surveillance& Satellite Communications Branch, Space & Missile Technology Directorate, USAF Phi lips Lab
6.4	**Bistatic Radar Applications** 315.330-2278	BILL WOLF wolfw@d af.mil	Deputy Chief, Surveillance Division, Systems and Photonics Directorate, Rome Laboratories. In[crest *in* advanced servo concepts. bistatics, signal processing, fusion
6.5	**Reflector Antennas** 213-740-4704	ALUIZIO PRATA prata@hertz usc.edu	Associate Professor of Electrical Engineering-Electrophysics, USC
6.6	**SBR Antennas and Processing Systems for Moving Target Detection**	HAL MALL(OT malliot@rddvax decnetlockheed com	Senior Systems Engineer, Lockheed Martin Missiles and Space Co.. Interest in airborne and satellite borne radar and RF remote sensing systems
6.7	**Large Aperture Imaging Systems** 505-846-9944	LAWRENCE ROBERTSON robertsl@plk af.mil	Staff Engineer, Nichols Research Interest in dynamics and control of precision optical structures

7.0 Remote Sensing/Opto-Electronics

7.1	**Target Tracking Applications** 860-486--! 823	YAAKOV BAR.. SHALOM ybs@ee uconn edu	IEEE Distinguished Lecturer, IEEE Fellow Professor of E E Univ. of Corm Organizer of National Short Courses on Target Tracking, Author of 5 books and over 200 papers
7.2	**Remote Sensing I** 609-921-3892, X258	BILL MILLER bmiller@scitec com	Senior Scientist and Vice President, Scitec Inc., subsidary of TRW. Interest in remote sensing, IR Phenomenology, combustion
7.3	**Remote Sensing II** 310.336.1047	DAVID LAWRIE lawrie@courier4,aero org	Manager, Sensing & Simulation Section, Sensing & Exploitation Dept The Aerospace Corp. Interests in electro-optical instrumentation and data analysis, electro optical sensor modeling and simulation, constellation-level simulations of space surveillance systems
7.4	**Advanced Sensors** 562.942-5247	PAUL S PENCIKOWSKI pencikowsk@aolcom	Advanced Project Manager, Northrop Grumman Corp Specialist in rapid prototyping of advanced sensor or command and control applications and displays
7 s	**Advanced IR Sensors** 310-336-8836	TERRY LOMHEIM lomheim@courier4 aero.org	Distinguished Engineer, The Aerospace Corp, Sensor Systems Sub Division. Interest in space-based visible & infrared electro-optical design and development, advanced visible and infrared focal plane technology, hyperspectral sensors, color imaging.
7.6	**Opto-Electronics I** 702-588-4176	PETER GUILFOYLE peterg@opticomp.com	IEEE Distinguished Lecturer, Founder, President & CEO Opticomp Corporation (developing technologies for optical interconnects); has 7 patents & more than 70 publications.
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9.0 Communications

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9.2 Satellite-Based Communications NORBERT KLEINER
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11.0 Aerospace Missions

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11.2 Implementing Missions Faster, Better, Cheaper
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